CLAIMS

1. A process for making a UV cured material comprising:

providing a dielectric material having a first dielectric constant, having a first elastic modulus, and having a first material hardness; and

UV curing the dielectric material to produce a UV cured dielectric material having a second dielectric constant which is within about ±20% of the first dielectric constant, having a second elastic modulus which is greater than the first elastic modulus, and having a second material hardness which is greater than the first material hardness.

2. The process of claim 1 wherein the dielectric material is selected from an organic material, an inorganic material, or a combination thereof.

3. The process of claim 1 wherein the dielectric material is selected from a hydrogen silsesquioxane (HSQ) dielectric material, a methylsilsesquioxane (MSQ) dielectric material, a carbon doped oxide (CDO) dielectric material, a hydrogenated silicon oxy-carbide (SiCOH) dielectric material, a benzocyclobutene (BCB) dielectric material, an arylcyclobutene based dielectric material, a polyphenylene based dielectric material, or a combination thereof.

4. The process of claim 1 wherein the dielectric material is produced by depositing a dielectric coating on a substrate using a spin-on process, a chemical vapor deposition process, a plasma assisted chemical vapor deposition process, an evaporation process, a reactive evaporation process or a self assembled deposition process.

5. The process of claim 1 wherein the dielectric material is selected from a dense dielectric material, a porogen-generated porous dielectric material, a solvent-formed porous dielectric material, or a molecular engineered porous dielectric material, or combinations thereof.

6. The process of claim 1 wherein the dielectric material is UV cured for no more than or about 300 seconds.

7. The process of claim 1 wherein the dielectric material is UV cured for between about 60 and about 180 seconds.

8. The process of claim 1 wherein the dielectric material has a wafer temperature that is greater than or about 80°C during UV curing.

9. The process of claim 1 wherein the dielectric material has a wafer temperature that is between about room temperature and about 450°C during UV curing.

10. The process of claim 1 wherein the dielectric material is UV cured at a process pressure that is less than or about equal to atmospheric pressure.

11. The process of claim 1 wherein the dielectric material is UV cured at a process pressure that is greater than or about equal to atmospheric pressure.

12. The process of claim 1 wherein the dielectric material is UV cured at a UV power between about 0.1 and about 2000 mW/cm^2.

13. The process of claim 1 wherein the dielectric material is UV cured with a process gas purge, wherein the purge gas is selected from N_2, O_z, Ar, He, H_2, H_2O vapor, CO_z, C_xH_y, C_xF_y, $C_xH_zF_y$, air, and combinations thereof, and wherein x is an integer between 1 and 6, y is an integer between 4 and 14, and z is an integer between 1 and 3.

14. The process of claim 1 wherein the dielectric material is UV cured using a UV wavelength spectrum between about 100nm and about 400nm.

15. The process of claim 1 wherein the increase in elastic modulus between the first elastic modulus of the dielectric material and the second elastic modulus of the UV cured dielectric material is greater than or about 50%.

16. The process of claim 1 wherein the second elastic modulus of the UV cured dielectric material is greater than or about 2.5 GPa.

17. The process of claim 1 wherein the second elastic modulus of the UV cured dielectric material is between about 4 GPa and about 12 GPa.

18. The process of claim 1 wherein the increase in material hardness between the first material hardness of the dielectric material and the second material hardness of the UV cured dielectric material is greater than or about 50%.

19. The process of claim 1 wherein the second material hardness of the UV cured dielectric material is greater than or about 0.25 GPa.

20. The process of claim 1 wherein the second material hardness of the UV cured dielectric material is between about 0.25 and about 1.2 GPa.

21. The process of claim 1 further comprising post-UV treating the UV cured dielectric material to provide a post-UV treated, UV cured dielectric material having a third dielectric constant which is less than the second dielectric constant, having a third elastic modulus which is greater than or within about ±20% of the second elastic modulus, and having a third material hardness which is greater than or within about ±20% of the second material hardness.

22. The process of claim 21 wherein the third dielectric constant of the post-UV treated, UV cured dielectric material is between about 1.1 and about 3.5.

23. The process of claim 21 wherein the third dielectric constant of the post-UV treated, UV cured dielectric material is between about 1.6 and about 2.4.

24. The process of claim 21 wherein the post-UV treating is thermal annealing.

25. The process of claim 24 wherein the UV cured dielectric material is annealed at a temperature less than or about 450°C.

26. The process of claim 24 wherein the UV cured dielectric material is annealed at a temperature between about 150 and about 450°C.

27. The process of claim 24 wherein the UV cured dielectric material is annealed for no more than or about 60 minutes.

28. The process of claim 21 wherein the post-UV treating is plasma treating by exposing the UV cured dielectric material to a plasma condition at elevated temperatures.

29. The process of claim 28 wherein the UV cured dielectric material is plasma treated at a plasma power between about 500 and about 3000 W.

30. The process of claim 28 wherein the UV cured dielectric material is plasma treated at a temperature between about 100 and about 450°C.

31. The process of claim 28 wherein the UV cured dielectric material is plasma treated for no more than or about 90 seconds.

32. The process of claim 28 wherein the UV cured dielectric material is plasma treated at a process pressure between about 1 Torr and about 10 Torr.

33. The process of claim 28 wherein the UV cured dielectric material is plasma treated with a plasma gas, wherein the plasma gas is selected from N_2, O_2, Ar, He, H_2, C_xH_y, fluorine-containing gas, or combinations thereof, and wherein x is an integer between 1 and 6, and y is an integer between 1 and 14.

34. The process of claim 21 wherein the post-UV treating is UV treating by exposing the UV cured dielectric material to a UV condition.

35. The process of claim 34 wherein the UV cured dielectric material is UV treated for no more than or about 300 seconds.

36. The process of claim 34 wherein the UV cured dielectric material is UV treated for between about 60 and about 180 seconds.

37. The process of claim 34 wherein the UV cured dielectric material is UV treated at a temperature between about room temperature and about 450°C.

38. The process of claim 34 wherein the UV cured dielectric material is UV treated at a process pressure that is less than or about equal to atmospheric pressure.

39. The process of claim 34 wherein the UV cured dielectric material is UV treated at a process pressure that is greater than or about equal to atmospheric pressure.

40. The process of claim 34 wherein the UV cured dielectric material is UV treated at a UV power between about 0.1 and about 2000 mW/cm^2.

41. The process of claim 34 wherein the UV cured dielectric material is UV treated with a process gas purge, wherein the purge gas is selected from N_2, O_z, Ar, He, H_2, H_2O vapor, CO_z, C_xH_y, C_xF_y, $C_xH_zF_y$, air, and combinations thereof, and wherein x is an integer between 1 and 6, y is an integer between 4 and 14, and z is an integer between 1 and 3.

42. The process of claim 34 wherein the UV cured dielectric material is UV treated using a UV wavelength spectrum between about 100nm and about 400nm.

43. The process of claim 1 wherein the UV curing occurs at vacuum conditions or at conditions without the presence of oxygen or oxidizing gases.

44. A UV cured dielectric material prepared by the process of claim 1.

45. A post-UV treated, UV cured dielectric material prepared by the process of claim 21.

46. An electronic device containing a UV cured dielectric material prepared by the process of claim 1.

47. An electronic device containing a post-UV treated, UV cured dielectric material prepared by the process of claim 21.

48. A substrate having a UV cured coating prepared by the process of claim 1.

49. A substrate having a post-UV treated, UV cured coating prepared by the process of claim 21.

50. The process of claim 1 further comprising:

placing the dielectric material into a process chamber;

evacuating or purging the process chamber to remove room air;

supplying a process gas to the process chamber;

heating the dielectric material to a process temperature of about 450°C or less; and

exposing the dielectric material to UV radiation with wavelengths in the region of between about 100 and about 400nm.

51. The process of claim 50 wherein the UV radiation is provided by a UV light source selected from a microwave driven light source, an arc discharge light source, a dielectric barrier discharge light source, or an electron impact generated light source.

52. The process of claim 50 wherein the dielectric material is heated by a heat source selected from an infrared light source, an optical light source, a hot surface, or a UV light source.

53. A UV cured dielectric material having a dielectric constant between about 1.1 and about 3.5, an elastic modulus that is about 50% greater than a non-UV cured dielectric material, and a material hardness that is about 50% greater than a non-UV cured dielectric material.

54. A UV cured dielectric material having a dielectric constant between about 2.0 and about 2.9, an elastic modulus that is about 50% greater than a non-UV cured dielectric material, and a material hardness that is about 50% greater than a non-UV cured dielectric material.

55. A process for making a UV cured material comprising:

providing an uncured advanced low-k dielectric material; and

UV curing the dielectric material at a time of no greater than about 5 minutes, or at a temperature of no greater than about 450°C to produce a UV cured dielectric material, wherein the total thermal budget of the UV curing is reduced by greater than about 50% as compared to a furnace curing process.

56. The process of claim 55 wherein the dielectric material is selected from an organic material, an inorganic material, or a combination thereof.

57. The process of claim 55 wherein the dielectric material is selected from a hydrogen silsesquioxane (HSQ) dielectric material, a methylsilsesquioxane (MSQ) dielectric material, a carbon doped oxide (CDO) dielectric material, a hydrogenated silicon oxy-carbide (SiCOH) dielectric material, a benzocyclobutene (BCB) dielectric material, an arylcyclobutene based dielectric material, a polyphenylene based dielectric material, or a combination thereof.

58. The process of claim 55 wherein the dielectric material is produced by depositing a dielectric coating on a substrate using a spin-on process, a chemical vapor deposition process, a plasma assisted chemical vapor deposition process, an evaporation process, a reactive evaporation process or a self assembled deposition process.

59. The process of claim 55 wherein the dielectric material is selected from a dense dielectric material, a porogen-generated porous dielectric material, a solvent-formed porous dielectric material, or a molecular engineered porous dielectric material, or combinations thereof.

60. The process of claim 55 wherein the dielectric material is UV cured for between about 60 and about 180 seconds.

61. The process of claim 55 wherein the dielectric material has a wafer temperature that is between about room temperature and about 450°C during UV curing.

62. The process of claim 55 wherein the dielectric material is UV cured at a process pressure that is less than or about equal to atmospheric pressure.

63. The process of claim 55 wherein the dielectric material is UV cured at a process pressure that is greater than or about equal to atmospheric pressure.

64. The process of claim 55 wherein the dielectric material is UV cured at a UV power between about 0.1 and about 2000 mW/cm^2.

65. The process of claim 55 wherein the dielectric material is UV cured with a process gas purge, wherein the purge gas is selected from N_2, O_z, Ar, He, H_2, H_2O vapor, CO_z, C_xH_y, C_xF_y, $C_xH_zF_y$, air, and combinations thereof, and wherein x is an integer between 1 and 6, y is an integer between 4 and 14, and z is an integer between 1 and 3.

66. The process of claim 55 wherein the dielectric material is UV cured using a UV wavelength spectrum between about 100nm and about 400nm.